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LISTS OF SPECIES

Fishes of Sungai Enam and Sungai Telang in Temengor Reservoir, Perak, Malaysia

Zarul Hazrin Hashim [1*], Amir Shah Ruddin Md. Shah [1], Mohd. Syaiful Mohammad [2], Mashhor Mansor [1] and Shahrul Anuar Mohd. Sah [1]

1 University Sains Malaysia, School of Biological Sciences. 11800 USM, Pulau Pinang, Malaysia.
2 Pulau Banding Rainforest Research Center. Pulau Banding, 33300 Gerik, Perak, Malaysia.
* Corresponding author. E-mail: *zarulzorro@yahoo.com*

ABSTRACT: An inventory study of fishes was carried out from June 2003 to May 2004 at Sungai Enam and Sungai Telang, which was last logged 40 years ago. In spite of the negative impacts of logging, the study recorded a total of 21 fish species in these headwaters, comprising nine families. Sungai Telang recorded 19 species with 11 species classified as "locally rare", whereas Sungai Enam recorded 11 species with nine species classified as "locally rare". When species from previous studies were included, the total number of species recorded in Sungai Enam and Sungai Telang was 28 and 27 species respectively. The presence of *Devario regina*, *Neolissochilus soroides* and *Poropuntius smedleyi* in all inventory studies conducted indicate that both headwaters are healthy, and function as sources of clean water, nutrient supplies and fish recruits for Temengor Reservoir.

INTRODUCTION

Freshwater fishes in Peninsular Malaysia are relatively diverse. Of approximately 1000 species in the South-East Asian Tropics, more than 200 species can be found in Peninsular Malaysia (Ismail and Sabariah 1995). However, this situation is likely to increase as further discoveries are made (Kottelat and Lim 1992; Ng and Lim 1993; Ismail and Sabariah 1995; Tan 1998; Ng 2002; Ng 2003; Tan and Ng 2005). Recent studies showed that 470 species comprising 15 families have been recorded in Malaysia (Chong *et al.* 2010).

Temengor Reservoir, which is the second largest man-made reservoir in Peninsular Malaysia, provides an environment that supports diverse fish assemblages. Sungai Enam (*Sungai = River*) and Sungai Telang, which flow into Temengor Reservoir (Figure 1), were last logged 40 years ago. Despite the negative impacts of logging, water quality in these two headwaters has recovered and is classified as Class I (Hashim *et al.* 2011).

Due to poor documentation of Malaysia freshwater fishes as mentioned by Chong *et al.* (2010), we present a checklist of fish community, which was generated from a study conducted from June 2003 to May 2004 along Sungai Enam and Sungai Telang. Spatial analyses involving inter- and intra-river comparisons on fish indices are presented. In temporal analyses, fish assemblage data from 1993 to 2011 were compiled and compared for inventory checklist and future reference purposes.

MATERIALS AND METHODS

This study was conducted in two streams of second order flowing into Temengor Reservoir, the Sungai Enam and Sungai Telang. Presence of sand-bed, bedrock, sand-bedrock, cobbles, pebbles, logs and woody debris, characterized these streams. Streams were chosen have into account access conditions and the absence of previous studies.

In the streams, all pools along a transect of 500 m from the river mouth were numbered and used in pool selections for stream stratification and sampling purposes. All numbered pools were stratified evenly into three zones, namely, the upper, middle and lower zones. Stratified and random sampling designs were adopted for this study, where two pools were randomly selected from each zone in each sampling effort.

A portable electro-fisher with voltage ranging from 100 V to 1100 V and pulsed DC option, together with scoop nets were used to catch fish in this study. The electro-fisher

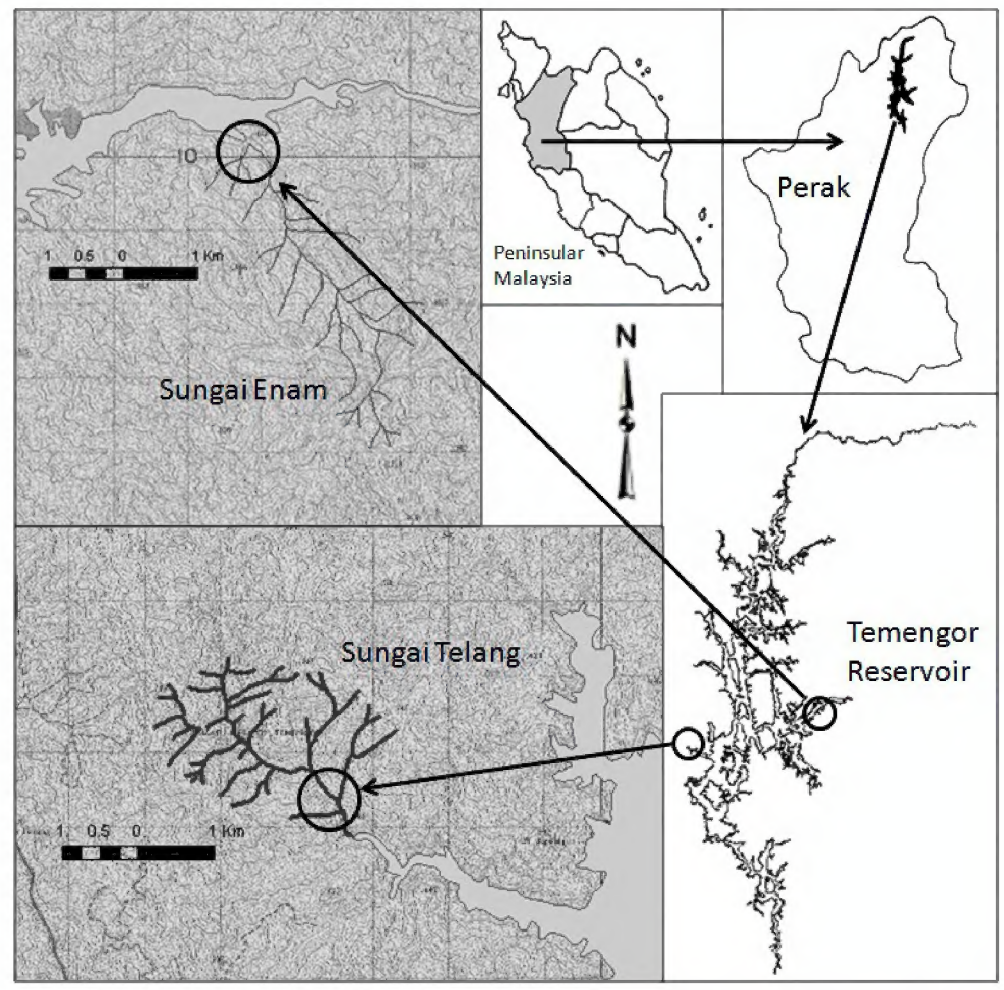

FIGURE 1. Location of sampling area at Sungai Enam (05°28.061' N, 101°17.377' E) and Sungai Telang (05°30.921' N, 101°27.601' E) in Temengor Reservoir, Perak, Malaysia.

operator and two assistants explored each selected pool from one end to another three times. Captured fish were placed in a bucket filled with stream water to keep the fish alive. The fish were then identified and measured for total length and weight before being released back into the pool of origin. Unidentified and representative specimens of each species were preserved in 10% formalin for voucher collection and species identification in the laboratory. Species taxonomy, identification and classification system follow *Ikan air tawar di Semenanjung Malaysia* (*Freshwater fishes of Peninsular Malaysia*) by Mohsin and Ambak (1991) as main reference and Kottelat *et al.* (1993), Rainboth (1996) and Chong *et al.* (2010) as additional references. Check spellings, authorships and dates of publication of each species name were validated consulting Eschmeyer and Fricke (2011). Voucher specimens were deposited at the School of Biological Sciences, Universiti Sains Malaysia. Fishing permit for this study has been approved by Fisheries Department of Perak State.

Diversity and evenness were calculated based on Shannon-Weiner diversity indices as given by Krebs (1999), whereas species rarity was calculated following Othman *et al.* (2002), which was based on an adaptation from the guidelines used for birds by Wong (1985). According to the guidelines, a species considered as 'locally rare' whenever the total individual of the respective species is less than 2% of the total catch in the respective area.

All fish data from the studies conducted in Sungai Enam from 1993 [Ismail and Sabariah 1995; Md. Akhir 1999 (*unpublished data*); Berryhill 2003 (*unpublished data*)] to the most recent sampling in 2011 were compiled and compared.

Results and Discussion

Twenty-one fish species comprising nine families were recorded during the study. Nineteen species were recorded in Sungai Telang with 11 species classified as "locally rare", whereas in Sungai Enam, 11 species were recorded with nine species classified as "locally rare" (Table 1). Shannon-Wiener diversity and evenness indices were higher in Sungai Telang (2.74; 0.64) compared to Sungai Enam (1.69; 0.49). Both streams showed an ascending trend of diversity index from the upper zone to the middle and lower zones. In Sungai Enam, the diversity indices were 1.43, 1.45 and 1.99, respectively, whereas the diversity indices in Sungai Telang were 2.46, 2.59 and 2.88, respectively.

The ascending trend of diversity index from the upper to the lower zones in both streams indicates community expansion by species addition, which also reflects the function of stream order, as suggested by Horton (1945) and Strahler (1957). According to Cowx and Welcomme (1998), the number of fish species and abundance in streams depends on four undamaged riverine interactive pathways, which are temporal dimension, longitudinal pathways, lateral interactions and vertical interactions.

Species distribution by stream zones showed that only four species were present in all zones in both streams, namely *Devario regina* (Fowler 1934), *Neolissochilus soroides* (Duncker 1904), *Poropuntius smedleyi* (de Beaufort 1933) and *Puntius binotatus* (Valenciennes 1842) (Table 1). In Sungai Enam, the total number of individuals recorded in the upper, middle and the lower zones were 352 (5 species), 366 (5 species) and 278 (10 species), respectively. In Sungai Telang, the total number of individuals recorded was 348 (14 species), 458 (13

Table 1. Fish distribution and abundance by stream zones recorded from June 2003 to May 2004 at Sungai Enam and Sungai Telang, Temengor Reservoir, Perak, Malaysia. Classification system follows Mohsin and Ambak (1991). Superscript 'E' and 'T' after a species name indicate species rarity (locally rare) in the respective river. E = Sungai Enam, T=Sungai Telang. T-L: Sungai Telang Lower zone; T-M: Sungai Telang Middle zone; T-U: Sungai Telang Upper zone; E-L: Sungai Enam Lower zone; E-M: Sungai Enam Middle zone; E-U: Sungai Enam Upper zone; -: absent; +: Number of individuals 1-50; ++: Number of individuals 51-100; +++: Number of individuals 101-150; ++++: Number of individuals 151-200.

FAMILY	SPECIES	E-L	E-M	E-U	T-L	T-M	T-U
Cyprinidae	*Rasbora caudimaculata* Volz, 1903 [T]	-	-	-	-	-	+
	Rasbora sumatrana (Bleeker, 1852)	-	-	-	+	++	++
	Devario regina (Fomler, 1934)	+++	++++	+++	+	+++	+++
	Puntius binotatus (Valenciennes, 1842) [E]	+	+	+	+	+	+
	Puntius lateristriga (Bleeker, 1851) [E]	+	-	-	+	+	+
	Mystacoleucus marginatus (Valenciaennes, 1842) [T]	-	-	-	+	+	+
	Poropuntius smedleyi (de Beaufort, 1933)	++	++++	++++	+	+++	++
	Hampala macrolepidota Kuhl and Van Hasselt, 1823 [ET]	+	-	-	+	+	+
	Osteochilus vittatus (Valenciennes, 1842) [E]	+	+	-	+	+	+
	Cyclocheilichthys apogon (Valenciennes, 1842) [T]	-	-	-	+	+	-
	Labiobarbus leptocheilus (Valenciennes 1842) [T]	-	-	-	-	-	+
	Neolissochilus soroides (Duncker, 1904)	+	+	+	+	+	+
Bagridae	*Mystus castaneus* Ng, 2002 [T]	-	-	-	-	+	-
	Hemibagrus nemurus (Valenciennes, 1840) [E]	+	-	-	+	+	+
Clariidae	*Clarias macrocephalus* Günther, 1864 [E]	-	-	+	-	-	-
Siluridae	*Ompok bimaculatus* (Bloch, 1974) [ET]	+	-	-	-	-	+
Belonidae	*Xenentodon canciloides* (Valenciennes, 1840) [T]	-	-	-	-	-	+
Channidae	*Channa striata* (Bloch, 1793) [T]	-	-	-	+	+	-
Osphronemidae	*Osphronemus goramy* Lacepède, 1801 [T]	-	-	-	+	-	-
Nandidae	*Pristolepis fasciata* (Bleeker, 1851) [T]	-	-	-	+	-	-
Eleotridae	*Oxyeleotris marmorata* (Bleeker, 1852) [E]	+	-	-	-	-	-

Table 2. Species checklist of fishes in Sungai Enam and Sungai Telang, Temengor Reservoir, Perak, Malaysia. Classification system follows Mohsin and Ambak (1991).
Data based on the following studies: (a) Ismail and Sabariah (1995), (b) Md Akhir (1999; *unpublished*), (c) Berryhill (2003; *unpublished*), (d) current study, (e) latest intensive 1-day inventory check (July 2011). Studies by (b), (c), (d) and (e) were carried out by using electro-shocker.

SPECIES	Voucher number (USM/ Bio/...)	Sungai Enam 1994 (a)	Sungai Enam 1998 (b)	Sungai Enam 2002 (c)	Sungai Enam 2004 (d)	Sungai Enam 2011 (e)	Sungai Telang 1998 (b)	Sungai Telang 2004 (d)
Oxygaster anomalura Van Hasselt, 1823	1998/063	-	+	-	-	-	-	-
Rasbora caudimaculata Volz, 1903	1998/109	-	+	-	-	-	+	-
Rasbora sumatrana (Bleeker, 1852)	2011/350	+	+	+	-	+	+	+
Devario regina (Fomler, 1934)	2011/347	+	+	+	+	+	+	+
Puntius binotatus (Valenciennes, 1842)	2011/411	-	+	+	+	+	+	+
Puntius lateristriga (Valenciennes, 1842)	2004/191	-	-	+	+	-	+	+
Mystacoleucus marginatus (Valenciaennes, 1842)	2011/351	+	+	-	-	+	+	+
Poropuntius smedleyi (de Beaufort, 1933)	2011/349	+	+	+	+	+	+	+
Barbonymus schwanenfeldii (Bleeker, 1853)	1998/032	-	+	-	-	-	-	-
Hampala macrolepidota Kuhl and Van Hasselt, 1823	2011/358	-	+	+	+	+	+	+
Osteochilus vittatus (Valenciennes, 1842)	2011/352	+	+	+	+	+	+	+
Osteochilus microcephalus (Valenciennes, 1842)	1998/072	-	+	-	-	-	-	-
Cyclocheilichthys apogon (Valenciennes, 1842)	2011/359	-	+	-	-	+	-	+
Labiobarbus leptocheilus (Valenciennes 1842)	2004/201	-	-	-	-	-	-	+
Tor tambroides (Bleeker, 1854)	1998/021	-	+	-	-	-	+	-
Neolissochilus soroides (Duncker, 1904)	2011/348	+	+	+	+	+	+	+
Glyptothorax platypogonides (Bleeker, 1855)	2002/410	-	-	+	-	-	-	-
Amblyceps mangois (Hamilton, 1822)	1998/134	-	-	-	-	-	+	-
Hemibagrus nemurus (Valenciennes, 1840)	2011/357	-	-	+	+	+	-	+
Hemibagrus planiceps (Valenciennes, 1840)	1008/100	+	-	-	-	-	+	-
Mystus castaneus Ng, 2002	2004/228	-	-	-	-	-	-	+
Clarias macrocephalus Günther, 1864	2004/279	-	-	-	+	-	-	+
Clarias teijsmanni Bleeker, 1857	2011/356	+	+	+	-	+	+	-
Ompok spp.	2004/124	-	-	+	+	-	-	+
Xenentodon canciloides (Bleeker, 1853)	2011/355	-	+	-	-	+	+	+
Channa striata (Bloch, 1793)	2011/353	-	+	-	-	+	+	+
Channa lucius (Cuvier, 1831)	1998/091	-	-	-	-	-	+	-
Channa micropeltes (Cuvier, 1831)	1998/056	-	+	-	-	-	+	-
Osphronemus goramy Lacepède, 1801	2004/312	-	+	-	-	-	+	+
Monopterus albus (Zuiew, 1793)	2002/545	-	+	+	-	-	-	-
Pristolepis fasciata (Bleeker, 1851)	2004/164	-	-	-	-	-	-	+
Pseudogobiopsis oligactis (Bleeker, 1875)	2002/242	+	+	+	-	-	+	-
Oxyeleotris marmorata (Bleeker, 1852)	2004/177	-	-	-	+	-	-	-
Total Number of Species		**9**	**21**	**14**	**11**	**13**	**20**	**19**

species) and 136 (14 species) respectively. The differences in the number of species from the upper zone to the lower zone between Sungai Enam and Sungai Telang were probably due to stream slope and waterfalls. According to Schlosser (1982), the changes in fish community structure and function along the physical gradients support the qualitative contention of the stream continuum concept, i.e. "Consistent shifts in community organization are associated with spatial or temporal changes in resource availability, channel morphology and flow regime". A shift from shallow, temporally variable habitats to deeper, relatively stable areas in conjunction with seasonal variation resource availability, are major proximate factors associated with changes in fish community organization (Schlosser 1982).

In Garonne River, Spain, Santoul *et al.* (2005), found that the richness of fish species increased progressively from upstream to downstream, and the longitudinal patterns of fish assemblages partitioned the river into clear biogeographic areas. Jansen *et al.* (1999) agreed that a shift in numbers and species composition between sites could be partially related to differences in the available habitat. However, in the upper Saône River in France, Grenouillet *et al.* (2004) found that only the stream width and gradients significantly influenced local species richness among the different local habitat variables. These studies showed that the shape and the stream topography affect longitudinal distribution of fish species, as it could be a barrier for fish migration.

Migratory behavior is another means of fish movements along stream gradients. However, barriers such as high waterfalls and strong currents can restrict this. The absence of *Hampala macrolepidota* Kuhl and Van Hasselt 1823 and *Osteochilus vittatus* (Valenciennes 1842) in the upper zone

of Sungai Enam compared to Sungai Telang suggests that the migration process of these species to the upper zone of Sungai Enam was restricted due to certain barriers, such as the gradient slope and water velocity. Wootton (1992) stated that in stream and river environments, high waterfalls or rapids act as barriers, which prevent fish from migrating upstream. According to Yap (2002), fish diversity and composition similarity is often correlated with the morphology of the river basins, which were formed through geological processes. In Sungai Enam, the height between pools varies and the waterfalls can be more than five meters high. Besides, having steep ends and stream slope, the geographical condition of this area also produces strong currents. These conditions present significant barriers for fish attempting to migrate to the upper zone. The Sungai Telang, is steeper and differences in height conditions between the pools are smaller, which enables easier fish migration to the upper zone.

Based on studies conducted by Ismail and Sabariah (1995), Md. Akhir (1999; *unpublished data*), and Berryhill (2003; *unpublished data*), this study and the latest inventory check in July 2011, the total number of fish species recorded in Sungai Enam from 1993 to 2011 is 28 species, whereas the total number of fish species recorded in Sungai Telang is 27 species (Table 2). Among the 28 species in Sungai Enam, only four species were consistently captured in all studies, these are *D. regina*, *N. soroides*, *P. smedleyi* and *O. vittatus*. The first three species are common species in both Sungai Enam and Sungai Telang and are good indicator species for stream health due they require pristine and clear water quality for survival (Rainboth 1996).

The presence of the three common species in both headwaters streams during all studies conducted indicates that both headwaters are healthy and function as sources for clean water, nutrient supplies and fish recruits for the reservoir. The streams' physical and environmental characteristics, flow regimes, the four riverine interactive pathways and the ability of the fish species to migrate and to resist the strong currents determine species diversity and distribution along the gradients. The dynamics of the species richness throughout all inventory studies indicates that these rivers also serve as breeding ground for *Hampala macrolepidota* and *Osteochilus vittatus*. This type of study should be carried out for other headwater streams to ensure the sustainability of such ecosystem and fisheries importance.

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Appendix I. Some fish species found at Sungai Enam and Sungai Telang, Temengor Reservoir, Malaysia.

Rasbora sumatrana, 96 mm TL. (Picture by Zarul H Hashim).

Devario regina, 106 mm TL. (Picture by Zarul H Hashim).

Puntius binotatus, 150 mm TL. (Picture by Zarul H Hashim).

Poropuntius smedleyi, 108 mm TL. (Picture by Mohd. Syaiful Mohammad).

Hampala macrolepidota, 110 mm TL. (Picture by Zarul H Hashim).

Osteochilus vittatus, 235 mm TL. (Picture by Zarul H Hashim).

Cyclocheilichthys apogon, 112 mm TL. (Picture by Zarul H Hashim).

Neolissochilus soroides, 125 mm TL. (Picture by Zarul H Hashim).

Hemibagrus nemurus, 273 mm TL. (Picture by Zarul H Hashim).

Clarias teijsmanni, 243 mm TL. (Picture by Zarul H Hashim).